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Gentlemen:

This is the Third Quarterly Status Report on the extension to NASA Contract NASr-65(12) (IITRI Project No. A6122), entitled "An Airborne Experiment to Determine Temperature Variations Throughout the Solar Corona During the Eclipse of 12 November 1966." The period covered in the report is from 1 October 1966 until 31 December 1966. The work carried out during the period has been devoted to:

(i) The installation of the equipment in the NASA Convair 990, "Galileo".

(ii) The checking out of the equipment in flight under simulated eclipse conditions.

(iii) The staging of the eclipse expedition and the performance of the eclipse observation.

(iv) The commencement of the data analysis.

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EQUIPMENT INSTALLATION

The installation of the equipment was started on 26 September 1966 and was finally completed along with the installation of other experimenters on 18 October 1966. Figure 1 shows the location of the equipment in the floor plan of Galileo. Figures 2 and 3 are photographs of the equipment as installed in the aircraft. The installation was carried out at Moffett Field, California, with the technical assistance of NASA, Ames Research Center personnel.

EQUIPMENT ALIGNMENT AND SIMULATION FLIGHTS

Initial alignment of the equipment was carried out on the ground. The alignment consisted of:

(i) Optical alignment of the heliostat, telescope and interferometers.

(ii) Resolution check of the interferometers using an Hg λ5461Å source.

For the flight tests an auto collimation check was performed after each take-off followed by a resolution check with the Hg source. The equipment was in no way shock mounted and it was observed that a noise contribution from the aircraft vibration was being picked up at a frequency of about 200 cps. This did not prevent the satisfactory operation of the system as the fastest scanning rate was a factor of 100 times less than the frequency of the vibration. Figure 4 shows an example of the line profiles obtained in flight on the 5461Å Hg emission.

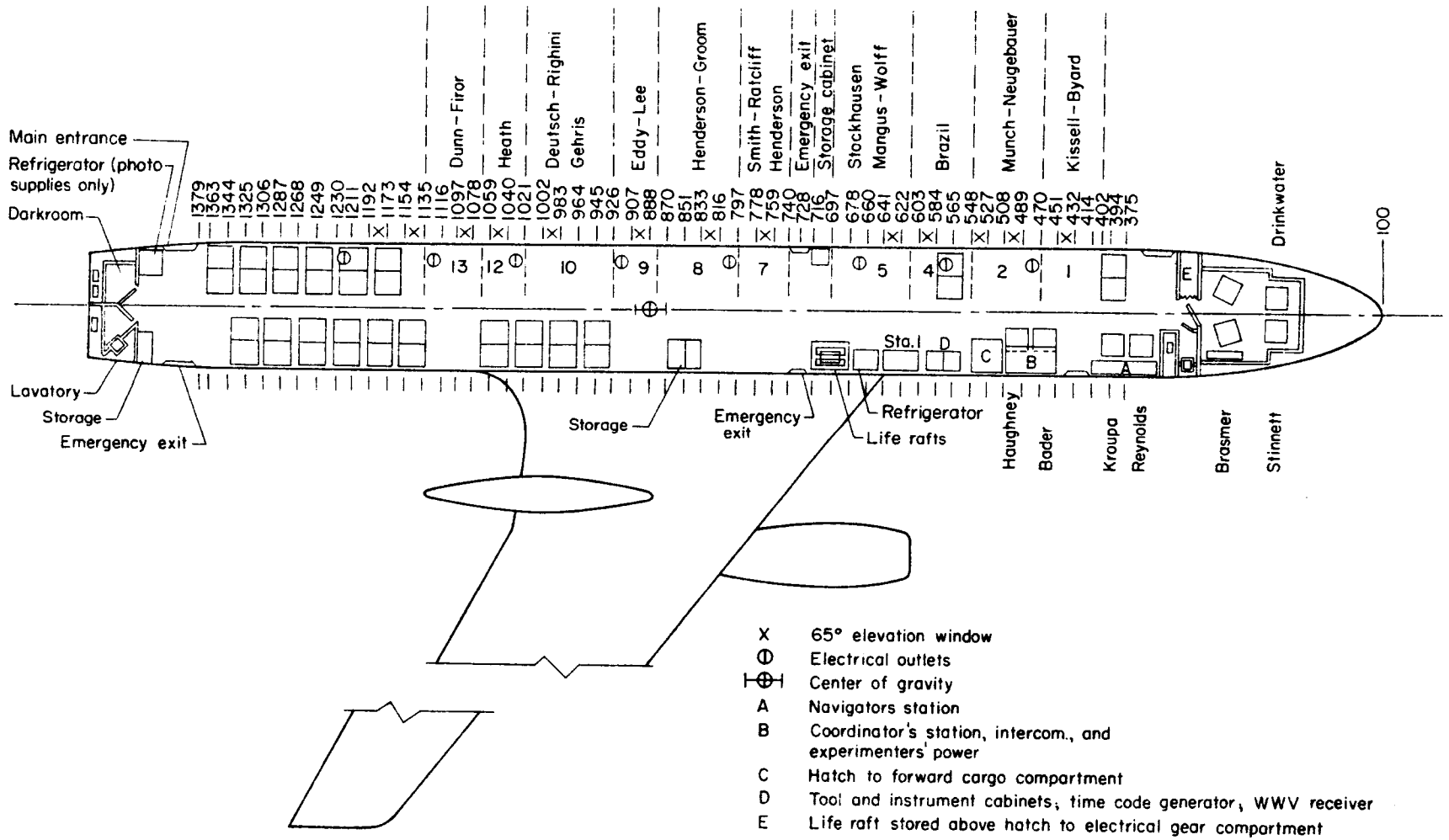

Fig. 1 Floor Plan of NASA Convair 990 "Galileo" for Eclipse Expedition, November, 1966

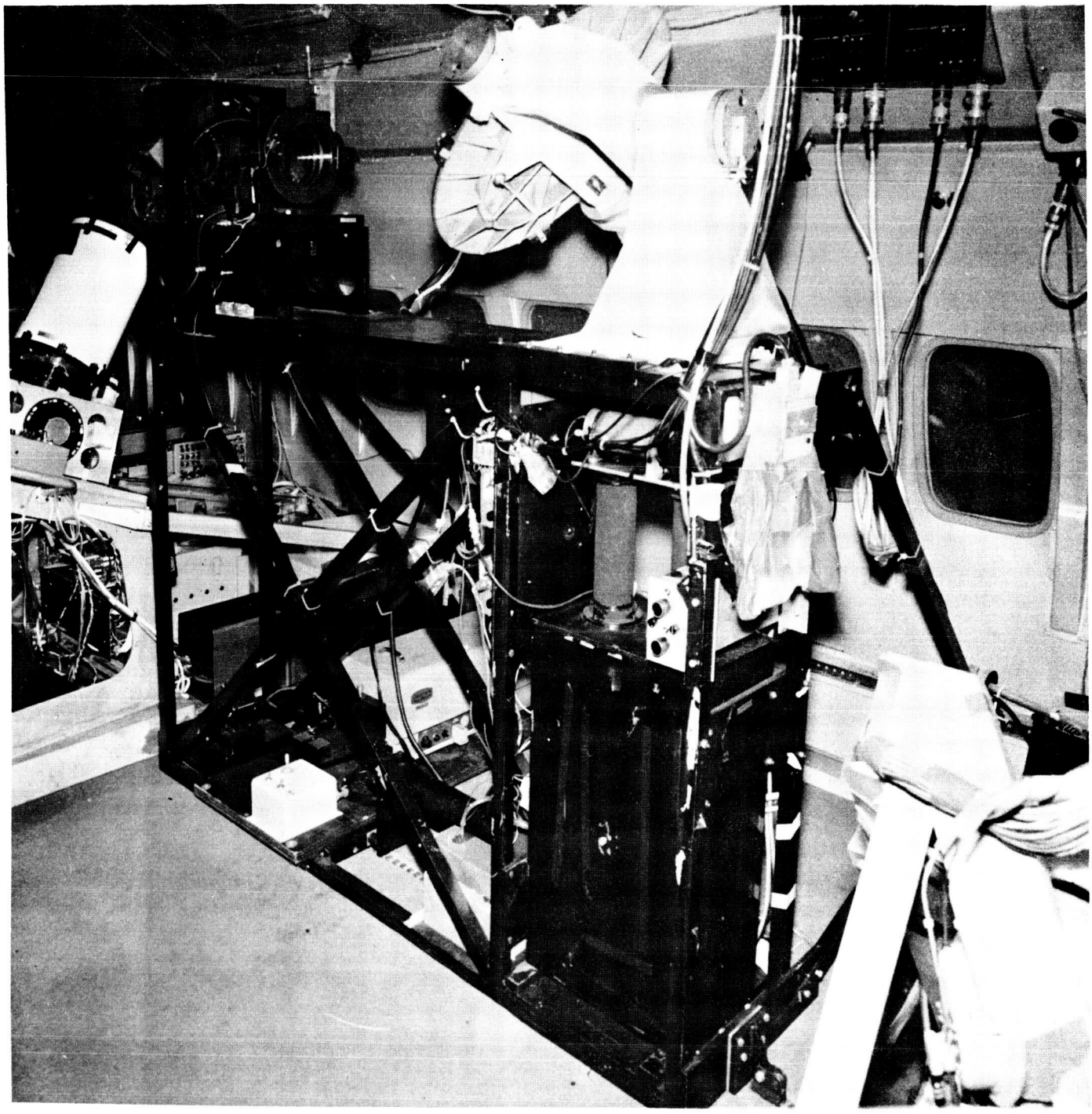

Fig. 2 Showing Optical System (Left side of Aircraft)

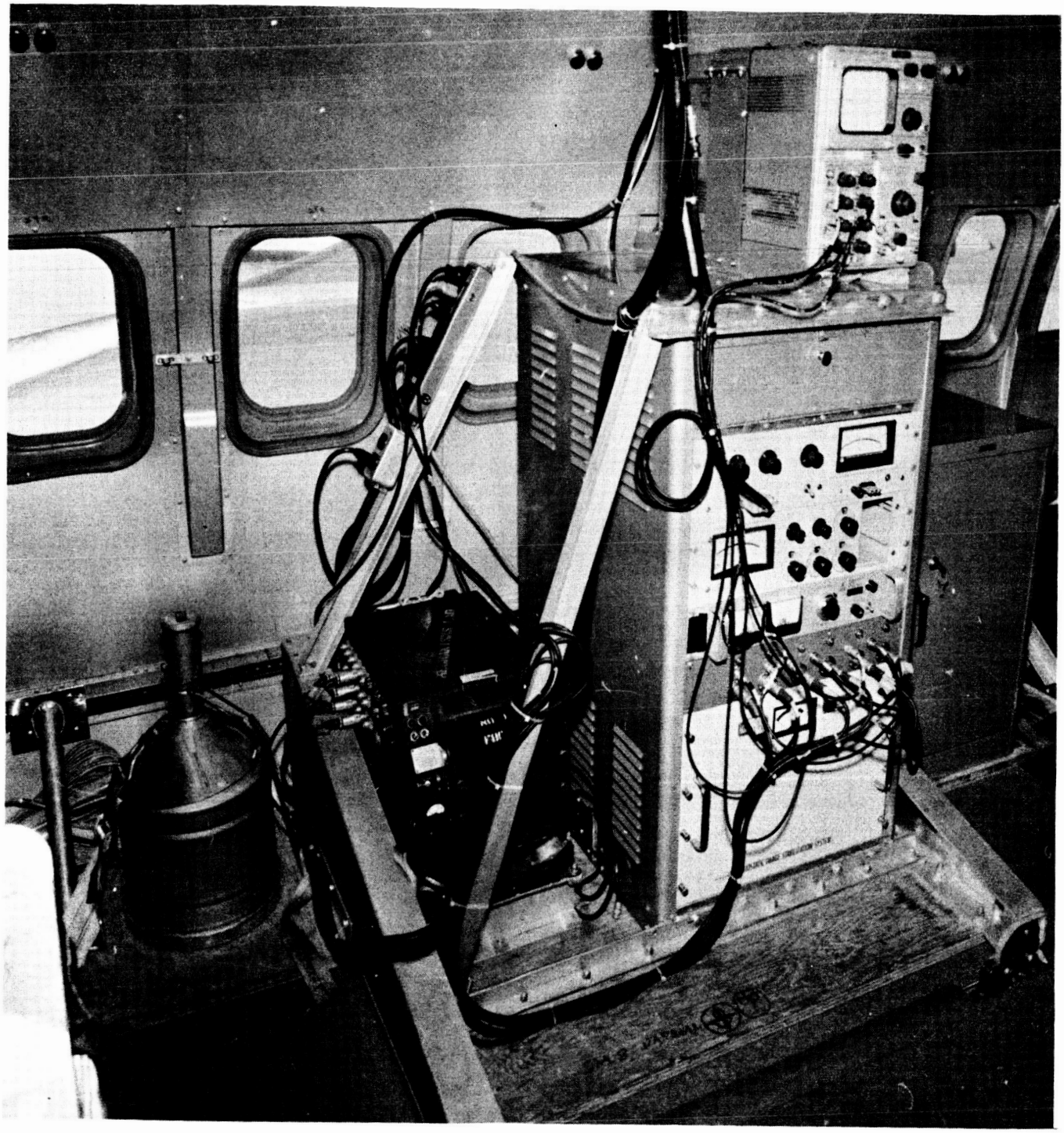

Fig. 3 Showing Electronic Amplifying and Recording System (Right Side of Aircraft)

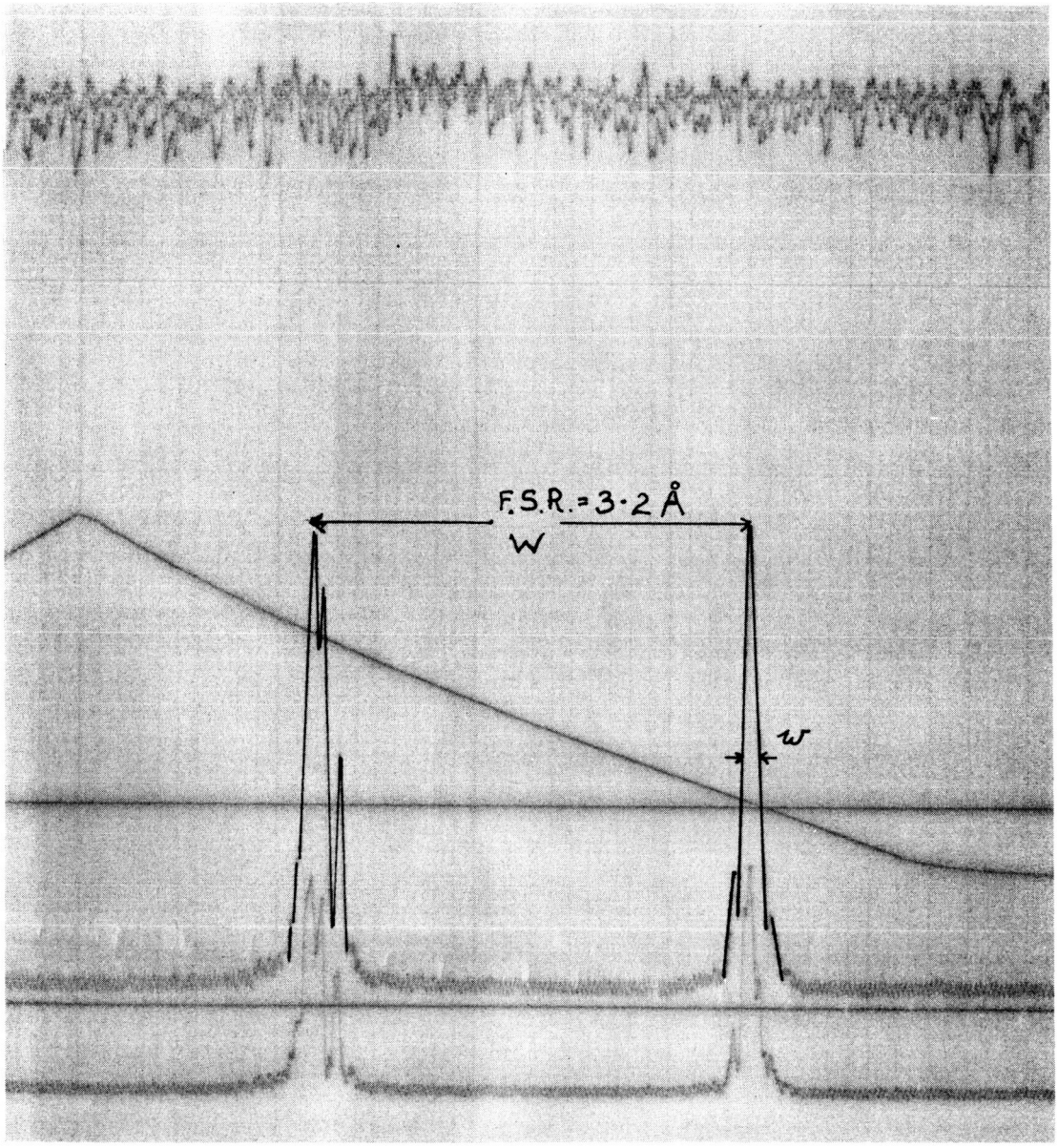

Figure 4. Showing the profiles of the Hg λ5461Å emission as measured by the λ5303A interferometer immediately after the eclipse. The different apparent widths in the two orders is due to the non-linearity of the magnetostrictive effect. This effect is allowed for in obtaining the true line profile. The effect of noise is more apparent when observing such a narrow line compared to the coronal emission but a reasonable value for the instrumental function can still be obtained, viz:-

$$\Delta\lambda = \frac{\omega}{W} \times FSR = \frac{1}{24} \times 3.2 = 0.13\text{Å}$$

Part of the trace has been overwritten to compensate for the poor reproduction quality of the data paper.

For the purposes of eclipse simulation during the practice flights, the aircraft was flown to a latitude which permitted the sun, or on night flights the moon, to be observed at, or near, the eclipse altitude of 70°. A curved path was flown for a period of about 15 minutes which maintained the relative bearing of the sun constant. The in-flight drift rate of the gyro-stabilized heliostat was checked during this time and a 5 minute totality simulation was counted off during which time observers carried out their eclipse drills.

In all, two day and two night flights were carried out from Moffett Field.

(iii) On Wednesday, 2 November 1966, Galileo with about 40 experimenters, crew and support personnel on board, departed Moffett Field for Porto Alegre, Brazil via San Juan, Puerto Rico. The expedition arrived at Porto Alegre on 3 November 1966 and during the interval until eclipse day, 12 November 1966, carried out three more navigation and practice flights.

On the eclipse flight on 12 November 1966, Galileo intercepted the umbra at 14h 16m 57s U.T., at a position 34° 26' South, 49° 51' West. Totality lasted for 206 seconds. During totality line profiles of the λ5303Å, Fe XIV, emission were recorded. The back up interferometer which was arranged to measure the λ6374Å, Fe X, emission developed a malfunction shortly before totality and no traces of the λ6374Å line were obtained. The signal from the interferometers was continuously

observed on the oscilloscope screen shown in Figure 3 and amplifier gains were adjusted, when required, to maintain the signal within predetermined limits.

A preliminary inspection of the λ5303Å data shows that emission profiles were obtained out to about 1.5 solar radii on the spectral scanning rate of two per second. At 1.5 solar radii the signal level was considered to be too low compared to the noise and a slow scan procedure was begun. In the slow scan procedure electronic damping was employed to reduce the noise level. A scan rate of about one scan per three of four seconds allowed the emission line to be observed out to 1.8 solar radii. During the slow scans the look direction in the corona was maintained close to Position Angle 90° for the different displacements from the sun's center. Figure 5 shows an example of the raw data obtained on the scanning rate of 2 scan per second. Figure 6 shows an example of the raw data obtained at a scanning rate of one scan per 3 seconds.

The analysis of the data obtained on the λ5303Å emission will take several months. When completed about 30 temperatures will be evaluated at various Position Angles out to 1.5 solar radii and about 15 additional temperatures out to about 1.8 solar radii, near to Position Angle 90°. The analysis procedure required has been outlined in a proposal submitted to NASA, Office of Space Science and Applications (IITRI Proposal No. 67-341A).

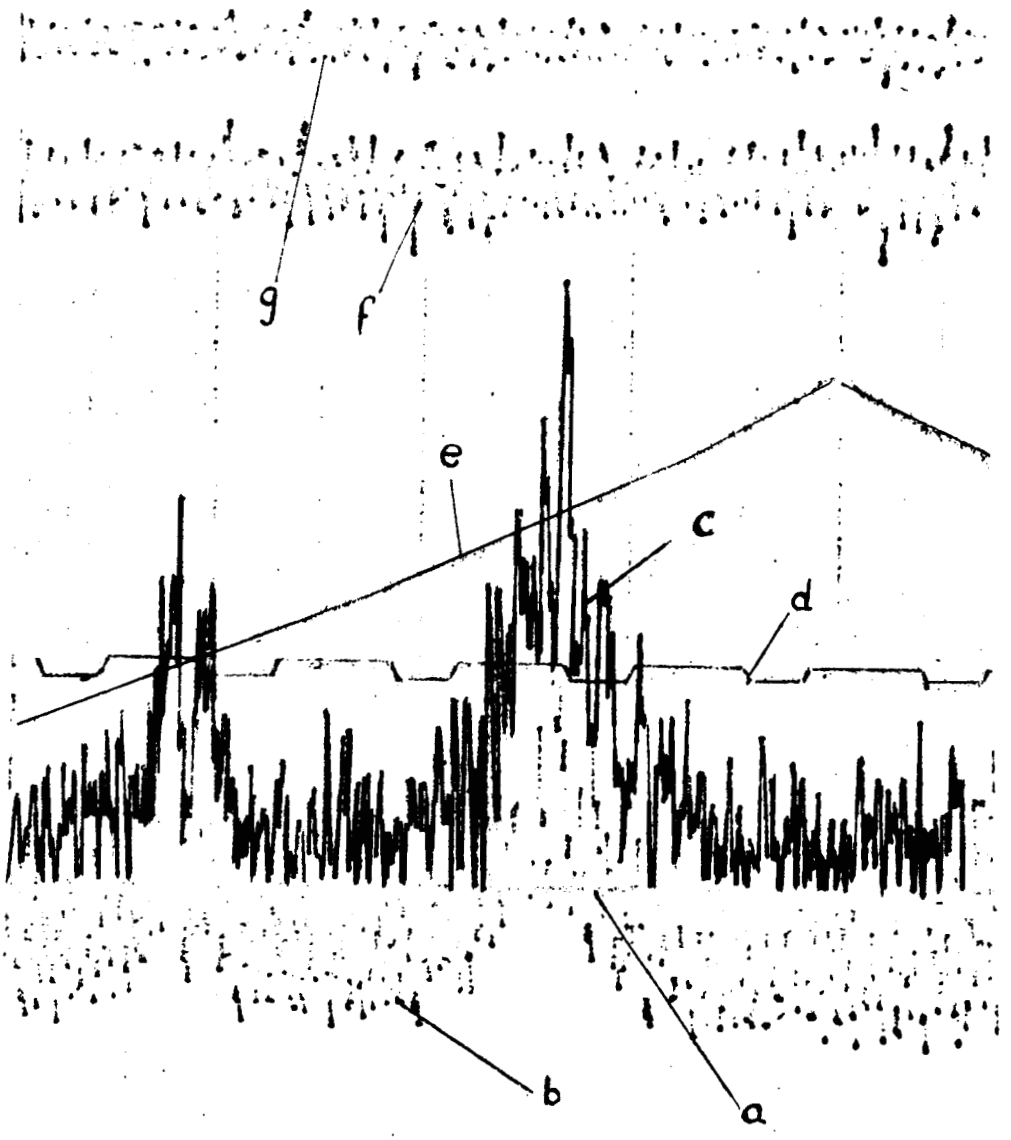

Figure 5. Showing raw data obtained at a scanning rate of 2 scans per second. This record pertains to a region about 1.1 solar radii from the sun's center. Identification of channels is:-

a - spare channel; b - λ5303 emission; c - λ5303 emission.

Channels b and c record the output of the λ5303 amplifier with a ratio of 2:1 in amplitude.

d - corona positional reference channel; e—current through interferometers; f and g - λ6374 emission records. (This interferometer failed to operate during eclipse.)

Curves c, d and e have been overwritten to compensate for the poor reproduction quality of the original data paper.

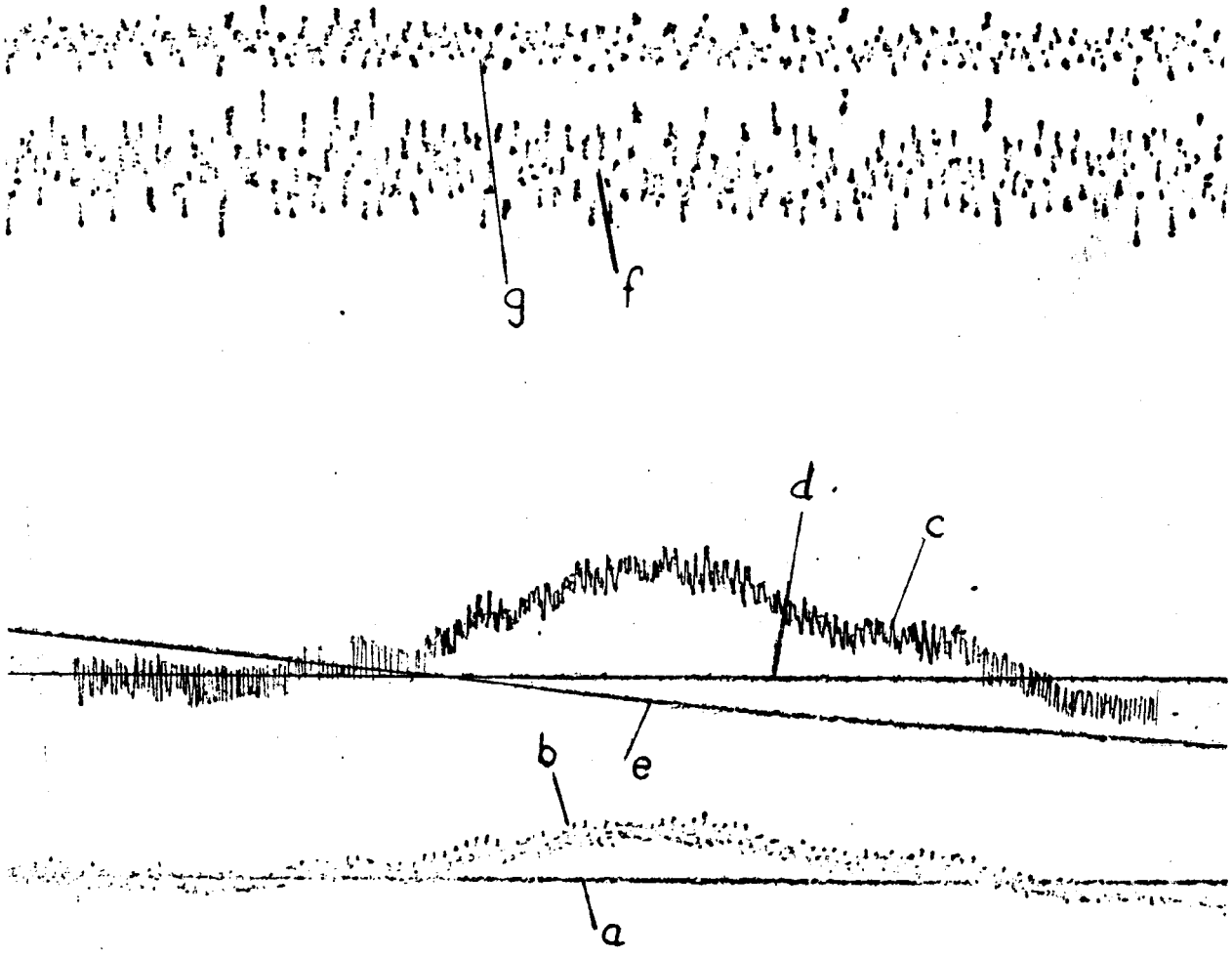

Figure 6. Showing raw data for a scanning rate of about 3 seconds per free spectral range (3.2Å). The curves are labeled as in Figure 1. Curves c,d and e have been overwritten to counteract the poor reproduction quality of the original record.

The emission shown on curves b and c corresponds to a region of the corona at 1.6 solar radii from the sun's center at position angle 90°. The profile of c will alter when e, the scanning current, has been linearized.

In summary, this report has described the final preparations for the eclipse expedition and the successful acquisition of eclipse data. IIT Research Institute appreciates the interest of the Solar Physics Branch of NASA, Office Space Science and Applications and its continued support of this research into the physics of the solar corona.

Respectfully submitted,
IIT RESEARCH INSTITUTE

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GH:ew

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